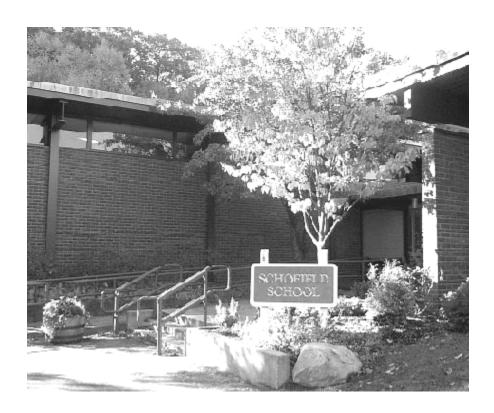
INDOOR AIR QUALITY ASSESSMENT

Schofield Elementary School 27 Cedar Street Wellesley, Massachusetts



Prepared by:
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Background/Introduction

In the Fall of 2001, the Massachusetts Department of Public Health (MDPH) submitted a proposal to the US Centers for Disease Control (CDC) to establish an environmental health tracking program in Massachusetts. CDC funded the Commonwealth of Massachusetts to develop the capacity for collecting a variety of health and environmental data, among which was a proposal to track indoor air quality in public schools. Over the course of this three year project, the MDPH proposes to evaluate indoor air quality in more than 100 schools. In addition, four communities who requested state assistance in evaluating indoor air quality were asked to participate in a focused effort involving more frequent evaluations of indoor air quality.

In response to concerns from parents and staff at the Schofield Elementary School (SES), 27 Cedar Street, Wellesley, Massachusetts, Janice Trainor-Tellier, Director, Wellesley Health Department (WHD) requested the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provide assistance in evaluating indoor air quality at the SES in October 2003. The request was prompted by concerns of mold in the kindergarten classroom carpets that may have resulted from the humid weather experienced during the first three weeks of August 2003. At the time of request, the MDPH asked Ms. Trainor-Tellier to collaborate with the Department by participating in the environmental tracking project. Ms. Trainor-Tellier agreed to have Wellesley be included as one of the communities with a school scheduled for more frequent sampling.

On October 15, 2003, a visit to conduct an indoor air quality assessment was made to this school by Michael Feeney, Director of the Emergency Response/Indoor Air Quality (ER/IAQ)

Program, BEHA. Mr. Feeney was accompanied by Leonard Izzo, Environmental Health

Specialist, WHD and staff from the SES and Wellesley School Department (WSD). This visit

focused primarily on water damage and potential mold growth in the building. Limited air sampling was conducted on this day because it was an early release day. A visual indoor air quality assessment was conducted in the majority of the school interior. An examination of the school exterior was also conducted.

A visit to conduct a comprehensive indoor air quality assessment as part of the CDC funded tracking project was made on November 25, 2003 by Cory Holmes and Sharon Lee, Environmental Analysts, ER/IAQ. Mr. Holmes and Ms. Lee were accompanied by Christopher Fogerty, Custodial Staff, SES. For portions of the visit, Mr. Izzo also accompanied BEHA staff.

As discussed, BEHA plans to conduct further air sampling at the SES over the course of this current school year as part of the MDPH's environmental public health tracking effort.

Results from assessments subsequent to November 2003 will be the subject to a separate report.

This additional testing was conducted in February 2004 and April 2004. Further testing will be scheduled in June 2004.

The SES is a single story brick building constructed in 1964. A wing was added in 1993 to the rear of the building, creating the music, art and kindergarten classrooms. The building is structured around a central courtyard and consists of general classrooms, music room, library, art room, and gymnasium. The school is located at the foot of a forested hill that has trees, which tower over the rear of the school. The rear of the school receives little direct sunlight. Windows were openable throughout the building.

Methods

BEHA staff performed visual inspection of building materials for water damage and/or microbial growth. Air tests for carbon monoxide, carbon dioxide, temperature and relative

humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAKTM Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID).

Results

The school houses approximately 410 students in grades K-5 and has a staff of approximately 40. The tests were taken during normal operations at the school. Test results appear in Tables 1 and 2.

Discussion

Ventilation

It can be seen from Table 1 that on October 15, 2003, carbon dioxide levels were below 800 in seven of eight areas surveyed, indicating inadequate ventilation in one area. On November 25, 2003, carbon dioxide levels were below 800 parts per million of air (ppm) in fourteen of twenty-nine areas surveyed (Table 2), indicating inadequate ventilation in nearly half of the areas surveyed. During both assessments, windows were open in a number of classrooms, which can greatlyreduce carbon dioxide levels.

Fresh air in classrooms is supplied by a unit ventilator (univent) system. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (Picture 1) and return air through an air intake located at the base of each unit (Figure 1). Fresh and

return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit. The majority of univents were not operating during either of the MDPH assessments. In the teachers' lounge, the ceiling-mounted univent is controlled by a wall switch and was set to the 'off' mode (Picture 2). Obstructions to airflow, such as papers and books stored on univents and items placed in front of univent returns, were seen in a number of classrooms (Picture 3). In order for univents and supply vents to provide fresh air as designed, these units must remain activated and allowed to operate while rooms are occupied. In addition, univent intakes and diffusers must remain free of obstructions. Some rooms (e.g., speech and language room) lacked both mechanical and a natural supply of fresh air. A fresh air source is necessary for the dilution of indoor air pollutants.

Exhaust ventilation in classrooms is provided by a mechanical system. Exhaust fans are located on the rooftop. In some rooms, air is drawn into exhaust vents located at the base of closets (Picture 4). Many of the closet exhausts were in disrepair. In some cases wooden blocks were used to prop open exhaust louvers to prevent blockage to exhaust ventilation (Picture 5). Louvers should be repaired to ensure proper function of exhaust ventilation. In other classrooms, mechanical exhaust ventilation is provided by wall- or ceiling-mounted exhaust vents. Exhaust vents in some of these rooms were off or drawing weakly. As with univents, in order to function as designed, exhaust vents must remain activated and operating while rooms are occupied. Moreover, the function of these exhausts were hindered by the room design and exhaust vent location. In some classrooms, ceiling-mounted exhaust vents were located above doorways (Picture 6). In such cases, open doors prevent proper functioning of the ceiling-mounted exhaust vents. Rather than exhausting classroom air, these vents draw air from the

hallway through the open doors. The open hallway door reduces the effectiveness of the exhaust vent to remove common environmental pollutants from classrooms.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical ventilation system, the systems must be balanced subsequent to installation to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing was unknown at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see <u>Appendix A</u>.

Temperature measurements ranged from 69° F to 72° F on October 15, 2003 (Table 1) and 68° F to 77° F on November 25, 2003 (Table 2), which were very close to the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. Building staff expressed a variety of temperature control/comfort complaints at the time of both assessments. Building occupants expressed concerns about excess heat in the special education room and in the speech/language room. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Thermostat function is integral to maintaining temperatures within the comfort range. Mr. Fogerty indicated that the SES had thermostats manufactured by three different companies. According to Mr. Fogerty, some of the thermostats at the SES are difficult to calibrate because of the design. Thermostats should be calibrated to ensure proper function of ventilation equipment or be replaced if not functioning.

The relative humidity measured in the building ranged from 51 to 56 percent on October 15, 2003, which was within the BEHA recommended comfort range. On November 25, 2003, the relative humidity measured in the building ranged from 24 to 33 percent, which was below the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60

percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As previously discussed, the primary concern of the initial visit was mold growth that may have resulted from the extended period of humid weather experienced in August 2003. In the experience of BEHA staff, excessively humid weather can provide enough airborne water vapor to create adequate conditions for mold growth in buildings. Relative humidity in excess of 70 percent can provide an environment for mold and fungal growth (ASHRAE, 1989). In general, materials that are prone to mold growth can become colonized when moistened for more than 24-48 hours. Since hot, humid weather persisted in Massachusetts for more than 14 days during the month of August (The Weather Underground, 2003), materials in many schools and buildings were moistened for an extended period of time.

According to building staff, mold growth was observed on wall-to-wall carpets in the kindergarten area. These carpets were cleaned, not replaced. No visible mold colonies were observed on carpeting at the SES. However, a "damp forest" odor was detected in classroom KH, which is located in the 1993 wing. This odor can indicate that excessively damp outdoor air was being introduced into the classrooms of this wing, which would make carpeted floors vulnerable to prolonged moistening and possible mold growth. The following characteristics may make the 1993 wing prone to moisture infiltration:

- The 1993 wing is immediately adjacent to a forested area. The trees prevent the sun from drying soil around the exterior wall of the wing.
- The ground at the base of the 1993 wing was covered with leaves and pine needles,
 which prevent the drying of soil. If repeatedly moistened, leaves and pine needles can
 also become mold growth medium (Picture 7).
- Unlike the rest of the building, which uses internal roof drains, the 1993 wing has a roof gutter/downspout system that empties rainwater at the base of the building.
- Cement conduits were installed beneath downspouts to direct water away from the building. Rainwater has compressed the soil beneath the cement conduits, which in some cases have sunk to slope *towards* the building (Picture 8). Chronic exposure to rainwater has resulted in moss growth on the building foundation. Moss can also hold water against the building. Over time, moss growth can result in damage to the slab.
- Univent fresh air intakes for the 1993 classrooms are located directly above the moistened ground (Picture 1).

The perpetual moistening of the ground beneath 1993 wing classroom fresh air intake vents combined with the excessive hot, humid weather in Massachusetts during August of 2003 likely provided the opportunity for moist air to wet carpets over an extended period of time, resulting in mold growth.

A refrigerator is located on carpeted flooring in the teachers' lounge. When warm, moist air passes over the cooler refrigerator, condensation can collect on the surface. Condensation is the collection of moisture on a surface at or below the dew point. The dew point is the temperature that air must reach for saturation to occur. Over time, condensation can collect and form water droplets. These water droplets can drip from the refrigerator surface to the carpeting.

As previously discussed, moistened carpeting can be a source of mold growth. Similarly, a water bubbler is located over a carpeted area. As with refrigerators, condensation can form on the surface of a water bubbler in a warm, moist environment. The condensation can drip from the bubbler and moisten carpeting. Overflow of the water bubbler or spills that often occur around the water source can also moisten carpeting.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildeweide to moldy porous materials is not recommended.

Other sources for water damage were also observed. Open seams between the sink countertop and wall were observed in several rooms (Picture 9). If not watertight, water can penetrate through the seam, causing water damage. In addition, a clapboard drawer was noted to be swelling (Picture 9). A step stool is located in a sink area. The porous material covering the stool was also noted to be water damaged (Picture 10). Water penetration and chronic exposure of porous and wood-based materials can cause these materials to swell and show signs of water damage. As discussed above, moistened materials that are not dried within 24 to 48 hours can become potential sources for mold growth.

Water damage was also noted on ceiling plaster and wooden ceiling planks in some areas (Pictures 11 and 12). School officials reported that the building has experienced historic roof leaks. A survey of the roof revealed water pooling on most of the roof surfaces (Picture 13). Evergreen trees were growing in close proximity to the building (Picture 14) and tree needles

had accumulated around roof drains, creating a dam-like effect that prevented proper drainage of rainwater. Tree needles can hinder the proper function of roof top drains, thereby preventing proper drainage. Freezing and thawing of pooled water can eventually degrade the integrity of the rubber membrane roof, causing cracks to form. These breaches can allow water to penetrate the building.

Shrubbery and other plants were growing in close proximity to slab walls (Picture 15). The growth of roots against the exterior walls can bring moisture in contact with wall brick. Plant roots can eventually penetrate the brick, leading to cracks and/or fissures in the foundation below ground level. Over time, this process can undermine the integrity of the building envelope, providing a means of water entry into the building through capillary action through foundation concrete and masonry (Lstiburek & Brennan, 2001).

Caulking around windows was missing/damaged in many areas (Picture 16). Missing caulking can make temperature control difficult and allow water to penetrate the building.

Replacement of caulking and repairs of window leaks are necessary to prevent water penetration and subsequent damage to building materials, which can lead to mold growth.

A number of aquariums and terrariums were located in classrooms. Classroom KR contained a fish tank with algae growth (Picture 17). Aquariums should be properly maintained to prevent microbial/algae growth, which can emit unpleasant odors. Similarly, terrariums should be properly maintained to ensure soil does not become a source for mold growth.

Lastly, plants were located on windowsills and near univents in several classrooms.

Some plants were found on top of univents, while a container filled with dry soil was found on top of another univent. Plants, soil and drip pans can serve as sources of mold growth, thus should be properly maintained. Over-watering of plants should be avoided and drip pans should

be inspected periodically for mold growth. Plants should also be located away from univents and ventilation sources to prevent aerosolization of dirt, pollen or mold.

Other Concerns

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants; however, the pollutant produced is dependent on the material combusted. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (µm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, BEHA staff obtained measurements for carbon monoxide and PM2.5 during the November 25, 2003 visit.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. According to the NAAQS established by the USEPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000). Outdoor carbon monoxide concentrations were non-detectable or ND (Table 2). Carbon monoxide levels measured in the school were also ND. *Carbon monoxide should not be present in a typical, indoor environment*. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels.

Several air quality standards have been established to address airborne pollutants and prevent symptoms from exposure to these substances. The MDPH established a corrective

action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions of reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient-Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997).

As previously mentioned, the US EPA also established NAAQS for exposure to particulate matter. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 microgram per cubic meter (μg/m³) in a 24-hour average (US EPA, 2000). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM2.5 standard requires outdoor air particle levels be maintained below 65 μg/m³ over a 24-hour average (US EPA, 2000). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, BEHA uses the more protective proposed PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor

environment. Outdoor PM2.5 concentrations were measured at $10 \,\mu\text{g/m}^3$ (Table 2). In most cases, PM2.5 levels measured in the school reflected outdoor levels and did not exceed the NAAQS.

Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors. In the instance of the SES, PM2.5 readings were slightly elevated above outdoor levels, but were below the NAAQS PM2.5 standard. The art room has a potter's wheel. Use of clay on potter's wheel and foot traffic is most likely a source of airborne particulate measured in this area. Moreover, inadequate ventilation prevents dilution of indoor pollutants. Many classroom univents were not operating at the time of assessment, resulting in an accumulation of indoor particulates.

Indoor air quality can also be negatively influenced by the presence of materials containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted during the November 25, 2003 visit. An

outdoor air sample was taken for comparison. Outdoor TVOC concentrations were ND (Table 2). Indoor TVOC concentrations were also ND.

In an effort to identify materials that can potentially increase indoor TVOC concentrations, BEHA staff examined classrooms for products containing these respiratory irritants. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Cleaning products were found on countertops and in unlocked cabinets beneath sinks in some classrooms (Picture 18). Like dry erase materials, cleaning products contain VOCs and other chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Of particular concern is a spray can of "Vandal Mark Remover", noted on the canister as being extremely flammable and producing vapors that are harmful (Picture 19). Upon discovery, BEHA staff asked Mr. Fogerty to promptly remove the item from the classroom. Also of concern are unlabelled bottles and containers located under sink cabinets. Products should be kept in their original containers or clearly labeled as to their contents for identification purposes, especially in the event of an emergency.

Other conditions that can affect indoor air quality were noted during the assessment. The interiors of several univents were examined. Walls in which univents are installed have spaces and holes within the air handling cabinet (Pictures 20 and 21). Of note is the heavy accumulation of dust around the edges of each hole, indicating unfiltered air passage. The existence of these holes allows for air to by-pass the installed filters, resulting in aerosolization of materials (e.g. dust) from the classrooms. In addition, spaces exist around heating pipes that

penetrate through the floor. Spaces of this nature can result in the univent drawing air and debris from the wall cavity or crawl space and distributing these materials to the interior of the building.

Univents were equipped with metal rack-type filters. The material used for filter media in these metal racks provides minimal filtration of respirable particulates that can be distributed by univents. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent (Minimum Efficiency Reporting Value equal to 9) would be sufficient to reduce many airborne particulates (Thornburg, 2000; MEHRC, 1997; ASHRAE, 1992). Note that increasing filtration can reduce airflow (called pressure drop), which can reduce the efficiency of the univents due to increased resistance. Prior to any increase of filtration, a ventilation engineer should be contacted to evaluate whether each univent can maintain function with more efficient filters.

Latex gloves were also found under the cabinet sink (Picture 22). Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix B (NIOSH, 1998).

Also of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were observed on windowsills, tabletops, counters, univents, bookcases and desks. The stored in classrooms provide surfaces for dust to accumulate.

Accumulation of these items (e.g., papers, folders, boxes) makes cleaning difficult for custodial staff. Dust can be irritating to eyes, nose and respiratory tract.

Accumulated chalk dust was noted in some classrooms. Chalk dust is a fine particulate that can easily become aerosolized. Once aerosolized, chalk dust can become irritating to eyes and the respiratory system. Similarly, pencil shavings were observed to be accumulating at the base of pencil sharpeners. In many classrooms, pencil sharpeners are stationed on bookcases located in front of windows or on univents (Picture 23). When windows are opened or univents are operating, pencil shavings can become airborne, providing a source of eye and respiratory irritation.

A number of ceiling- and wall-mounted exhaust vents were occluded with dust. If exhaust vents are not functioning, backdrafting can occur and aerosolize dust particles. As discussed, dust can be a source for eye and respiratory irritation. Once aerosolized, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently become re-aerosolized, causing further irritation. Also observed was a ceiling pipe with exposed fiberglass insulation (Picture 24). Fiberglass insulation can be a source of skin, eye and respiratory irritation to sensitive individuals.

Inactive bird's nests were noted in classrooms and reportedly serve as learning props (Picture 25). Bird's nests can contain bacteria and may also be a source of allergenic material. Nests should be placed in resealable bags to prevent aerosolization of allergenic material. These items should also be located away from univents fresh air diffusers.

A pet guinea pig was found in one classroom (Picture 26). The cage was lined with wood shavings and had accumulated wastes. Porous materials (i.e., wood shavings) can absorb animal wastes and can be a reservoir for mold and bacterial growth. Animal dander, fur and

wastes can all be sources of respiratory irritants. Animal cages should be cleaned regularly to avoid the aerosolization of allergenic materials and/or odors.

Lastly, food was found in open areas. Many food-based projects were placed uncovered on univents (Pictures 27 and 28). Food is an attractant to pests and rodents. Proper food storage is an integral component in maintaining indoor air quality. Food should be properly stored and clearly labeled. Moreover, food should be placed away from cleaning products, in separate storage areas. Reuse of food containers is not recommended since food residue adhering to the surface may serve to attract pests.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

- 1. Remove carpeting from the kindergarten area classroom to prevent future mold contamination. Consider replacing carpeting with a non-porous material that can be easily mopped/cleaned during a reoccurrence of hot, humid weather.
- 2. Remove leaves and pine needles from the ground around the 1993 wing.
- 3. Ensure rain gutters and drains are installed properly and directing water away from the 1993 wing. Remedial actions may include regrading the ground or installation of a drainage system to direct rainwater away from the 1993 wing.
- 4. Consider removing trees overhanging the roof to prevent the accumulation of leaves and pine needles damming roof drains.
- 5. Consult "Mold Remediation in Schools and Commercial Buildings" published by the US Environmental Protection Agency (US EPA, 2001) for more information on mold.

- Copies of this document can be downloaded from the US EPA website at: http://www.epa.gov/iaq/molds/mold_remediation.html.
- 6. Seal all holes in the walls of the univent air handling cabinets to limit filter bypass.
- 7. Operate both supply and exhaust ventilation continuously, independent of classroom thermostat control, during periods of school occupancy to maximize air exchange.
- 8. Remove all blockages from univents and exhaust vents to ensure adequate airflow.
- 9. Install passive door vents or undercut doors by at least one inch to provide a source of transfer air fresh air to rooms lacking a natural or mechanical fresh air supply.
- 10. Consult with an HVAC engineer to discuss repairing/replacing closet exhaust louvers.
- 11. Ensure classroom doors are closed to maintain ceiling-mounted exhaust vent function.
- 12. Consider adopting a balancing schedule for mechanical ventilation systems every 5 years, as recommended by ventilation industrial standards (SMACNA, 1994).
- 13. Consider replacing older thermostat models to ensure easy and proper calibration.
- 14. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g., throat and sinus irritations).
- 15. Install disposable filters in univents. Consider increasing the dust-spot efficiency of HVAC filters. Prior to any increase of filtration, each univent should be evaluated by a

- ventilation engineer to ascertain whether it can maintain function with more efficient filters.
- 16. Place tile or rubber matting underneath water bubblers and refrigerator in carpeted areas.
- 17. Seal breaches, seams, and spaces between sink countertop and backsplash to prevent water damage.
- 18. Remove plant growths against the exterior wall/foundation of the building to prevent water accumulation.
- 19. Clean and maintain aquariums and animal cages to prevent bacterial/microbial growth and associated odors.
- 20. Clean chalkboards and dry erase board trays regularly to avoid the build-up of particulates.
- 21. Relocate pencil sharpeners from the air diffusers of univents.
- 22. Store cleaning products properly and out of reach of students. Ensure spray bottles are properly labeled.
- 23. Remove latex gloves and other latex based materials.
- 24. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
- 25. Clean exhaust/return vents periodically to prevent excessive dust build-up.
- 26. Store nests in resealable bags to prevent aerosolization of irritants.
- 27. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

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Fresh Air Intake on Exterior Wall



Teachers' Lounge Supply Set To 'Off' Mode



Items On and Around Univent, Note Plant in Close Proximity to Air Diffuser



Exhaust Ventilation at the Base of Closet



Wooden Block Propping Open an Exhaust Louver



Ceiling Mounted Exhaust Vent Located near Doorway



Downspout Terminating Several Inches above Ground, Note Accumulated Leaves At Base of the Building



Cement Block Sloped towards Building



Seam between Sink and Countertop Baseboard and Swelling of Drawer Face



Water Damaged Step Stool



Water Damaged Ceiling Plaster



Water Damaged Wooden Ceiling In Gymnasium



Water Pooling on Rooftop



Evergreen Trees Branching Over School Rooftop



Shrubbery Growing in Close Proximity to the Building and Fresh Air Intakes



Damaged Rubber Gasket around Window



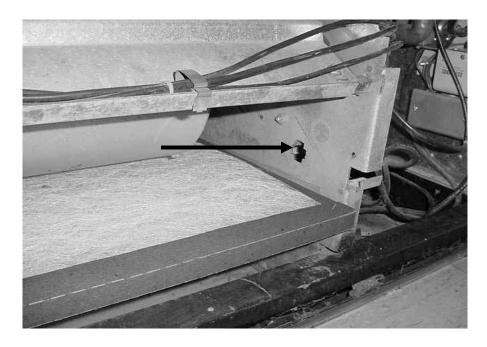
Algal Growth in Fish Tank



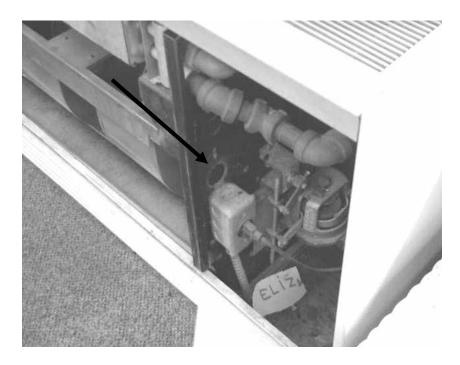
Cleaners Stored in Sink Cabinet



Vandal Mark Remover in Sink Cabinet



Open Holes in Univent Wall Case



Open Holes in Univent Wall Case



Latex Gloves in Sink Cabinet



Pencil Sharpener on Univent



Unwrapped Fiberglass Pipe Insulation



Nest in Cup



Guinea Pig Cage



Evaporated Salt Solution near Univent



Bleach and Flour In Sink Cabinet

| | Carbon | | Relative | | | Venti | lation | |
|----------------------|-------------------|------------|--------------|-------------------|---------------------|--------|---------|--|
| Location | Dioxide (*ppm) | Temp. (°F) | Humidity (%) | Occupants in Room | Windows Openable | Supply | Exhaust | Remarks |
| Outside (Background) | 391 | 60 | 65 | | | | | Cloudy, minimal wind |
| Classroom 4D | 611 | 71 | 53 | 20 | Y | Y | Y | |
| Classroom 2/3T | 632 | 72 | 52 | 0 | Y | Y | Y | Supply blocked chair Window open |
| Music | 917 | 72 | 55 | 21 | Y | Y | Y | Hallway door open |
| Classroom KI | 735 | 71 | 56 | 22 | Y | Y | Y | Hallway door open Window open |
| Classroom KH | 569 | 70 | 54 | 18 | Y | Y | Y | Hallway door open Outside exit door open Window open |
| Classroom 1K | 560 | 71 | 51 | 17 | Y | Y | Y | |
| Classroom 1M | 561 | 71 | 52 | 19 | Y | Y | Y | |
| Gym Office | 544 | 69 | 53 | 0 | N | Y | Y | |

* ppm = parts per million parts of air

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred

600 - 800 ppm = acceptable

> 800 ppm = indicative of ventilation problems

Schofield Elementary School 27 Cedar Street, Wellesley, MA

Indoor Air Results November 25, 2003 Table 2

| | Carbon | | Relative | Carbon | | | | | Venti | lation | |
|-----------------------|-------------------|--------------|--------------|--------------------|--------------|---------------|-------------------|---------------------|--------|---------|---|
| Location/ Room | Dioxide (*ppm) | Temp (°F) | Humidity (%) | Monoxide (*ppm) | TVOCs (*ppm) | PM2.5 (μg/m3) | Occupants in Room | Windows Openable | Supply | Exhaust | Remarks |
| Background (outdoors) | 380 | 49 | 32 | ND | ND | 10 | - | ı | - | 1 | Clear skies, NW wind ~15 mph; pooling water on roof; drains clogged with leaves/needles; trees and close proximity to roof |
| Room 5C | 596 | 68 | 30 | ND | ND | 10 | 22 | Y | Y | Y | Hallway door open; furniture blocking univent; PF; cleaners; plant in carpet; closet exhaust louver in disrepair |
| Room 5N | 458 | 71 | 27 | ND | ND | 10 | 0 | Y | Y | Y | 19 occupants left room 10 minutes prior to room assessment; univent occluded/blocked with dirt/debris and furniture; CD; DEM; clutter; cleaners; food storage/use |
| Speech and Language | 898 | 74 | 30 | ND | ND | 10 | 1 | N | N | Y | Exhaust off; Hallway door open; PF; clutter |
| Room 1S | 933 | 75 | 28 | ND | ND | 10 | 20 | Y | Y | Y | CD; plants |

ppm = parts per million parts of air

 $\mu g/m3 = microgram per cubic meter$

AD = air deodorizer

CT= ceiling tile

PF = personal fan

AHU = air-handling unit

TB = tennis balls

AP = air purifier **AC** = air conditioning DO = door open

UF = **upholstered furniture**

CD = chalk dust

MT= missing ceiling tile PC = photocopier

DEM = dry erase marker

WD = water damage ND = non-detect

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| | Carbon | | Relative | Carbon | | | | | Venti | lation | |
|-------------------|-------------------|--------------|--------------|--------------------|--------------|---------------|-------------------|---------------------|--------|---------|--|
| Location/ Room | Dioxide (*ppm) | Temp (°F) | Humidity (%) | Monoxide (*ppm) | TVOCs (*ppm) | PM2.5 (μg/m3) | Occupants in Room | Windows Openable | Supply | Exhaust | Remarks |
| Room 1L | 933 | 75 | 28 | ND | ND | 1 | 15 | Y | Y | Y | Univent blocked by clutter and furniture; CD; PF; DEM; cleaners; food storage/use |
| Room 2C | 803 | 71 | 28 | ND | ND | 1 | 21 | Y | Y | Y | Univent off; 3 of 3 windows open; PF;DEM; plants; food storage/use; clutter; cleaners; WD cardboard under sink |
| Room 2-3T | 890 | 73 | 27 | ND | ND | 15 | 17 | Y | Y | | Univent blocked will dir/debris, clutter, and furniture; CD; PF; DEM; plants; clutter; cleaners; unlabelled bottles under sink |
| Room 2E | 1034 | 74 | 33 | ND | ND | 1 | 24 | Y | Y | Y | Door open; univent blocked by plants and furniture; exhaust occluded with dirt/debris; CD; PF; DEM; cleaners |
| Room 3T | 887 | 77 | 28 | ND | ND | 1 | 19 | Y | Y | Y | Door open; 1 of 4 windows open; univent blocked by clutter and furniture; PF; DEM; dust; cleaners; terrarium; |
| ESL | 978 | 77 | 25 | ND | ND | 1 | 0 | N | N | N | Door open; laminator odors; juice/soda |

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CT= ceiling tile

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| Location/ Room | Dioxide (*ppm) | Temp (°F) | Humidity (%) | Monoxide (*ppm) | TVOCs (*ppm) | PM2.5 (μg/m3) | Occupants in Room | Windows Openable | Supply | Exhaust | Remarks |
| | | | | | | | | | | | machines; 3 Missing/ajar tiles |
| Room 4F | 1172 | 75 | 27 | ND | ND | 1 | 18 | Y | Y | Y | Univent blocked by clutter and furniture; exhaust weak; DEM; plants; clutter; terrarium |
| Room 4D | 1032 | 71 | 28 | ND | ND | 1 | 20 | | Y | Y | Univent blocked by clutter; DEM; cleaners; food storage/use; feather duster; vandal mark remover (an extremely flammable material with harmful vapors) stored under sink |
| Teacher's Room | 769 | 74 | 26 | ND | ND | 1 | 0 | N | Y | Y | Univent off; exhaust cluttered with dirt/debris; fridge and stove on carpet; water-damaged ceiling |
| Library | 785 | 73 | 28 | ND | ND | 1 | 19 | Y | Y | Y | Unfinished insulation; dust; hallway and exterior door open |
| Room K-2 (Sp. Ed) | 890 | 77 | 28 | ND | ND | 1 | 3 | Y | N | N | 1 of 2 windows open; Temperature complaints (hot) |

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Table 2 Indoor Air Results November 25, 2003

| | Carbon | | Relative | Carbon | | | | | Venti | lation | |
|--------------------|-------------------|--------------|-----------------|--------------------|--------------|------------------|-------------------|---------------------|--------|---------|--|
| Location/ Room | Dioxide (*ppm) | Temp (°F) | Humidity (%) | Monoxide (*ppm) | TVOCs (*ppm) | PM2.5 (μg/m3) | Occupants in Room | Windows Openable | Supply | Exhaust | Remarks |
| Office | 542 | 74 | 27 | ND | ND | 1 | 3 | N | | | Door open; photocopiers |
| Nurse's office | 633 | 73 | 22 | ND | ND | 1 | 0 | Y | N | N | Window mounted A/C with dusty filter; carpeted |
| Principal's office | 502 | 72 | 23 | ND | ND | 1 | 0 | Y | N | N | 1 of 1 window open ; window-mounted A/C |
| Psychology office | 667 | 71 | 26 | ND | ND | 1 | 4 | Y | N | N | |
| Cafeteria | 555 | 72 | 25 | ND | ND | 1 | ~100 | N | Y | Y | Supply and exhaust off; Supply blocked with clutter and furniture; WD ceiling |
| Gym office | 505 | 70 | 26 | ND | ND | 0 | 0 | N | N | Y | Exhaust off; |
| Room 1M | 933 | 73 | 28 | ND | ND | 1 | 20 | Y | Y | Y | 1 of 2 windows open; univent blocked with clutter and furniture; exhaust off (electric problem with exhaust causing switch to trip); CD, food storage/use; clutter; cleaners; bird nests; fountain over carpet |

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| | Carbon | | Relative | Carbon | | | | | Venti | lation | |
|-------------------|----------------|--------------|-----------------|-----------------|-----------------|---------------|-------------------|---------------------|--------|---------|---|
| Location/ Room | Dioxide (*ppm) | Temp (°F) | Humidity (%) | Monoxide (*ppm) | TVOCs (*ppm) | PM2.5 (μg/m3) | Occupants in Room | Windows Openable | Supply | Exhaust | Remarks |
| Room KR | 700 | 71 | 25 | ND | ND | 1 | 12 | Y | Y | Y | Door open; exhaust off (electric problem with exhaust causing switch to trip); CD; PF; DEM; cleaners; aquarium; dry leaves and grains on table |
| Room KH | 851 | 71 | 27 | ND | ND | 1 | 10 | Y | Y | Y | Door open; 1 of 5 windows open; univent blocked with furniture; plants; cleaners |
| Room K-1M | 889 | 75 | 26 | ND | ND | 1 | 22 | Y | Y | Y | Door open; univent blocked by clutter and furniture; CD; plants; clutter; cleaners; guinea pig; WD clapboard and stool; breach between sink/counter |
| Room 4FE | 833 | 75 | 27 | ND | ND | 1 | 18 | Y | Y | Y | Door open; univent blocked by clutter and furniture |
| Reading Room | 662 | 75 | 24 | ND | ND | 1 | 1 | Y | Y | Y | Door open; univent blocked by furniture; PF; DEM; cleaners |
| Art | 664 | 75 | 24 | ND | ND | 2 | 1 | N | Y | Y | Exhaust occluded with dirt/debris; potter's wheel; WD counter; latex gloves; PF; DEM; |

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Schofield Elementary School

27 Cedar Street, Wellesley, MA

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|-------------------|-------------------|--------------|--------------|-----------------|-----------------|---------------|-------------------|---------------------|--------|---------|---|
| Location/ Room | Dioxide (*ppm) | Temp (°F) | Humidity (%) | Monoxide (*ppm) | TVOCs (*ppm) | PM2.5 (μg/m3) | Occupants in Room | Windows Openable | Supply | Exhaust | Remarks |
| | | | | | | | | | | | plants; breach between sink/counter; exhaust in kiln room |
| Music room | 524 | 74 | 22 | ND | ND | 1 | 19 | N | Y | Y | Univent blocked by furniture; exhaust occluded with dirt/debris; CD; PF |

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